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ABSTRACT

This study investigated the utility of central auditory processing disorder (CAPD) assessments in 70 children being evaluated for learning and attention problems, by assessing their relationship to auditory-based neuropsychological tests with varying degrees of attentional, linguistic, and cognitive complexity. Students were given several tests to measure CAPD, including a comprehensive neuropsychological battery and tests of auditory perception, overactivity and attention, and intelligence. Results of the study found that tests of CAPD were most consistently related to tests of simple attention and language input. Neurocognitive task performance and more complex auditory attention were not consistently related to CAPD test performance. The study also found that IQ was mildly to moderately related to some tests of CAPD and needs to be taken into account when interpreting results. The study concludes that CAPD tests may be most sensitive to problems in children with inefficient selective auditory attention rather than those with phonologic processing difficulties and that the Screening Test for Auditory Processing Disorders alone may be inadequate in assessing auditory attention difficulties in children. (CR)

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Central Auditory Processing and Attention in Children with Learning/Behavior Problems

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Introduction

Central Auditory Processing Disorder (CAPD) is defined by the American Speech-Language-Hearing Association (ASHA, 1992) as deficits in the information processing of audible signals not attributed to impaired peripheral hearing sensitivity or intellectual impairment. CAPD has been implicated in numerous disorders in children, including learning disabilities and attention deficit disorder. Several different tests have been designed to tap into central auditory processing deficits, but the validity of the construct of central auditory processing and/or of the tests designed to assess CAPD is not yet established. Indeed, there is disagreement as to the extent CAPD may be related to auditory-phonologic rather than linguistic-cognitive or selective attention disorder (ASHA, 1992). Neither is there an understanding of the relationship between CAPD and neuropsychologically related constructs and assessment tools, although there is some evidence for the usefulness of CAPD data in the formulation of neuropsychological diagnosis (Bruner & Tucker, 1995). The purpose of this study was to investigate the utility of CAPD assessments in children being evaluated for learning and attention problems by assessing their relationship to auditorily-based neuropsychological tests with varying degrees of attentional, linguistic and cognitive complexity.

Subjects

Seventy children were selected, 53 male and 17 female, with a variety of learning and behavioral difficulties, and without severe emotional disturbance or known neurologic pathology. Children were initially screened for the central auditory processing evaluation by the use of a brief parent questionnaire, which included the following items: easily distracted, difficulty following verbal directions, slowed or delayed responses to verbal stimuli, asks for repetition frequently. A corollary question to this study was to investigate the relationship between general intellectual ability and measures of CAPD. Therefore IQ range was not restricted for the study, although the children had to be capable of comprehending test expectations. **TABLE 1** summarizes pertinent background data.

TABLE 1

Subjects	Mean (SD)	Range
Age	9.6 (2.47)	6-16
Grade	3.8 (2.42)	1-9
VIQ	95.6 (17.54)	49-129
PIQ	94.4 (15.97)	52-133
FSIQ	95.9 (16.28)	46-129

Method

Subjects were administered a battery of tests believed to measure CAPD: 1. The SCAN (Screening Test for Auditory Processing Disorders, Keith et al., 1988), including Filtered Words (**SCAN-FW**), an auditory closure task; Auditory Figure Ground (**SCAN-AFG**), word discrimination in the presence of a competing background; and Competing Words (**SCAN-CW**), monosyllabic words presented simultaneously to the right and left ear. Scaled scores, raw scores and a composite score (**SCAN-Comp**) were utilized in statistical analyses. 2. The Staggered Spondaic Word Test (**SSW**), two syllable words, presented in overlapping fashion to each ear. 3. Speech Discrimination in Noise (**SDIN**), ability to discriminate phonetically balanced kindergarten words in a background of speech noise. 4. Phonemic Synthesis (**PS**), sound discrimination, sequencing and blending. Tests were administered by a licensed audiologist in a double walled IAC Sound Suite, using SONY stereo cassette tape deck Model TC-K22 through a Madsen OB822 clinical audiometer.

Behavioral surveys and cognitive/neuropsychological tasks were administered as a part of a comprehensive neuropsychological battery. To evaluate level of attentional concerns, the Edelbrock Children's Attention Profile (CAP) scales for Overactivity (**CAP-OV**) and Inattention (**CAP-IN**) were extracted from the Pupil Rating Scale (Achenbach, 1991). General intelligence was assessed by Wechsler Intelligence for Children-Third Ed. (WISC-III) Verbal (**VIQ**), Performance (**PIQ**) and Full Scale (**FSIQ**) scores. Neuropsychological tests tapping auditory processing include, (WISC-III digit span forward (**DSF**) and backward (**DSB**), simple attention span; Attention Capacity Test (**ACT**), complex auditory attention; Syntactic Comprehension (**SYN**), auditory/language comprehension of semantically connected information; trial one of the California Verbal Learning Test-Children's Version (**CVLT-1**), auditory/language comprehension of semantically disconnected information; Wepman Test of Auditory Discrimination (**WTAD**), auditory discrimination; Lindamood Test of Auditory Conceptualization (**LAC**), complex auditory analysis/syntheses; and the Word Attack subtest of the Woodcock Johnson Psychoeducational Battery (**WA**), use of phonologic processes to analyze non-words.

Results

Gender differences were found for **CAP-OV** (Male M(sd)= 4.81(3.113), Female M(sd)=2.97(3.31); F=4.37, p=.04) and **CVLT-1** (Male M(sd)= 5.28 (1.36), Female M(sd)=6.68(3.5); F=5.94, p=.017). **TABLE 2** depicts SCAN and other Central Auditory Processing data. **TABLE 3** reveals means(sd) of the behavioral data: Children's Attention Profile Inattentive (**CAP-IN**) and Overactivity (**CAP-OV**) Scales. **TABLE 4** depicts data from neuropsychological measures.

TABLE 2
Means for Central Auditory Processing Data

Test	Mean (SD)	Range
SCAN-FW (scaled score)	10.38 (3.05)	4-18
SCAN-AFG (scaled score)	8.56 (2.90)	3-14
SCAN-CW (scaled score)	8.28 (3.14)	1-16
SCAN-Comp (scaled score)	13 7.43 (24.32)	0-171
SSW-rt ear (raw score)	13.53 (15.57)	0-72
SSW-lt ear (raw score)	19.27 ((18.33)	0-68
SDIN (raw score)	48.70 (8.16)	30-68
PS (raw score)	17.52 (5.56)	0-25

TABLE 3
Means for Behavioral Scales

Children's Attention Profile	Mean (SD)	Range
Inattention (**CAP-IN**)	5.40 (2.87)	0-14
Overactivity (**CAP-OV**)	4.36 (3.20)	0-13

TABLE 4
Means for Neuropsychological Data

Tests	Mean (SD)	Range
ACT	10.81 (3.67)	4-20
WTAD	7.80 (5.53)	2-27
WA	8.01 (6.3)	0-24
LAC	50.44 (25.97)	0-94
SYN	9.74 (2.77)	2-19
CVLT-1	5.46 (1.55)	2-9
DSF	4.90 (1.23)	2-8
DSB	2.91 (.99)	0-6

General Intelligence: **FSIQ** correlated significantly with several Central Auditory Processing, behavioral and neuropsychological variables (see **TABLE 5**). Also, since age correlated significantly with a number of dependent and independent variables, effects of age and IQ were partialled out in multiple regression analyses. Therefore data reported below are in the form of t-tests on Beta coefficients. Bonferoni corrections were computed for multiple tests (correction p = .008, for a p val. = .05).

Central Auditory Processing Data:

SCAN-FW: Trends for **SYN** (t=2.12, p=.038), **DSF** (t=2.25, p=.017), and **DSB** (t=1.8, p=.075), all other data NS.

SCAN-AFG: Trend for **ACT** (t=2.16, p=.04), **WTAD** (t=1.98, p=.059), **SYN** (t=1.67, p=.099), **DSF** (t=1.87, p=.066), all other data NS.

SCAN-CW: Significant relationships with **DSF** (t=3.25, p=.0019). Trend for **CVLT-1** (t=1.96, p=.05). All other data NS.

SCAN-Comp: Significant relationship with **DSF** (t=4.31, p=.0001). Trend for **CAP-IN** and **CAP-OV** (t=2,18, p=.036; t=2.58, p=.02). All other data NS.

SDIN: Trend for **CAP-OV** (t=2.10, p=.039). All other data NS.

SSW-rt ear: Significant relationship with **CVLT-1** (t=2.85, p=.003), and a trend for **SYN** (t=1.81, p=1.83). All other data NS.

SSW-lt-ear: Significant relationship with **SYN** (t=2.49, p=.018) and **CVLT-1** (t=3.57, p=.0007. All other data NS.

PS: Significant for **CAP-IN** (t=3.25, p=.0018). Trend for **CAP-OV** (t=2.3, p=.02), **CVLT1** (t=2.29, t=.025), **DSF** (t=2.02, p=.047), **DSB** (t=1.85, p=.069).

TABLE 5
Correlations With FSIQ: All Central Auditory Processing, Behavioral and Neuropsychological Data
Pearson R (p value)

SCAN-FW	SCAN-AFG	SCAN-CW	SCAN- FG	SDIN	SSW-R	SSW-L
.34(.004)	.18(.47)	.37(.001)	.22(.07)	.08(.52)	.38(.001)	.28(.017)

PS	CAP-IN	CAP-OV	ACT	WTAD	WA	LAC
37(.001)	.32(.008)	.007(.95)	20(.30)	.23(.24)	.07(.67)	.42(.09)

CVLT-1	SYN	DSF	DSB
.14(.20)	.25(.04)	.26(.03)	.32(.009)

Behavioral Data:
Children's Attention Profile Inattentive (**CAP-IN**) scales did not correlate significantly with neuropsychological measures although there were trends (R's ranging from .20-.41; p values ranging from .07-.09) for **LAC, WTAD, WA** and **DSB**. There were no significant correlations, nor trends, with the Overactivity (**CAP-OV**) Scales.

Discussion
Tests of CAPD appeared to be most consistently related to tests of simple attention and language input e.g. digit span and syntactic comprehension. The most notable exception is the relationship between staggered spondaic words (SSW) and the first presentation of the California Verbal Learning Test (CVLT-1), which were moderately correlated. Both of these tests involve listening, and responding to whole words. Neurocognitive tasks tapping more discrete phonological analysis and synthesis, and more complex auditory attention were not consistently related to CAPD tests. Therefore, CAPD tests may be most sensitive at problems in those children with inefficient selective auditory attention rather than phonologic processing concerns. Deficits with "selective auditory attention" have been previously been found in children diagnosed ADD (Dalebout et al., 1991). Data furthermore suggests that IQ is indeed mildly to moderately related to some tests of CAPD and therefore needs to be taken into account when interpreting results, although it is not clear that children with lower IQ's should be denied access to Central Auditory Processing assessments. Also, consistent with Cermak et. al. (1995), findings suggest that the SCAN alone may be inadequate in assessing auditory attention difficulties in children, and should be supplemented with other measures.

Limitations to this study include: lack of control group and the use of a population already preselected for auditory attention/language difficulties, which may have minimized some of the relationships between CAPD tests and neuropsychological measures.